NREL/PIX 22921

Retail Food Sales

Introduction

Grocery stores and supermarkets (large grocery stores that also stock products other than food) use more energy per square foot than almost any other commercial building subsector because the refrigeration systems that keep their food products fresh are energy intensive. According to the U.S. Department of Energy (DOE), grocery stores typically spend almost $5/ft^2/yr on energy, second only to the food service industry (restaurants) among commercial building types.[1] Grocery stores also often include large commercial kitchens and bakeries that add to energy use compared to general merchandise stores that sell only dry goods. The retail food sales sector represented 2% of commercial building floor space and 5% of the nation's total commercial building energy consumption[2] as of 2003, equivalent to approximately 870 trillion Btu/yr.[3]

The Commercial Building Partnership (CBP), a DOE-sponsored public/private, cost-shared program, paired selected commercial building owners and operators with representatives of DOE, its national laboratories, and private-sector technical experts. These teams explored energy efficiency measures (EEMs) across building systems—including some considered too costly or technologically challenging—and used advanced energy modeling to achieve peak whole-building performance. Modeling results were then included in new construction and retrofit designs to achieve significant energy reductions.

CBP aimed to achieve 50% energy savings compared to ANSI/ASHRAE/IES Standard 90.1-2004[4] for new construction; retrofits were designed to consume at least 30% less energy than either Standard 90.1-2004 or pre-retrofit consumption. After construction and commissioning of the project, laboratory staff continued to work with partners to collect and analyze data to verify the actual energy reduction.

CBP projects represented diverse building types in commercial real estate, including lodging, grocery, retail, higher education, office, and warehouse/storage facilities. Partners also committed to replicating low-energy technologies and strategies from their CBP projects throughout their building portfolios. This commitment represented a potential to impact almost 1.5 billion ft^2 of commercial real estate.

As a result of CBP projects, five sector overviews (General Merchandise, Higher Education, Lodging, Offices, and Retail Food Sales) were created to capture successful strategies and recommended EEMs that could be broadly applied across these sectors. These overviews were supplemented with individual case studies providing specific details of the decision criteria, modeling results, and lessons learned for each project. Sector overviews and CBP case studies will also be updated to reflect verified data and replication strategies as they become available.

The most compelling reason for grocery stores to save energy is the industry's thin profit margin — less than 2% according to the Food Marketing Institute.[5] For example, assuming a 2% profit margin, $1,000 saved in energy costs is equivalent to $50,000 in grocery sales. At the same time, the case studies show that other considerations such as corporate sustainability policy and customer shopping experience (including comfort) are also powerful drivers of change. Grocery stores currently rely on refrigerants that are costly to replace and environmentally detrimental when leaked. Companies are thus under pressure from regulatory agencies and the public to minimize their use of these refrigerants (eventually replacing them with options that neither deplete ozone nor impact climate) and to do so in a way that does not sacrifice energy performance.

[1] DOE Buildings Energy Data Book table 3.3.9 (http://buildingsdatabook.eren.doe.gov/TableView.aspx?table=3.3.9)
[2] DOE Buildings Energy Data Book table 3.2.2 (http://buildingsdatabook.eren.doe.gov/TableView.aspx?table=3.2.2)
[3] Based on an assumed total commercial consumption of 17.33 quadrillion Btu/yr from http://buildingsdatabook.eren.doe.gov/TableView.aspx?table=3.1.1
[4] Projects selected after 2009 used a baseline of ANSI/ASHRAE/IES Standard 90.1-2007 rather than ANSI/ASHRAE/IES Standard 90.1-2004.
[5] Food and Marketing Institute's 'Competition and Profit': http://www.fmi.org/docs/facts-figures/competitionandprofit.pdf?sfvrsn=2

Retail Food Sales Sector: Projects at a Glance

Company Name	SUPERVALU*	Target	Target	Walmart	Walmart	Whole Foods Market	Whole Foods Market	TOTAL
Project Type	Retrofit	Retrofit	New	Retrofit	New	Retrofit	New	—
Climate Zone	5A cool-humid	5B cool-dry	6A cold-humid	5B cool-dry	3A warm-humid	5A cool-humid	4A mixed-humid	—
Ownership	Owner-occupied	Owner-occupied	Owner-occupied	Owner-occupied	Owner-occupied	Tenant, pays utilities	Tenant, pays utilities	—
Square Footage	40,000 ft^2	173,000 ft^2	133,000 ft^2	200,000 ft^2	200,000 ft^2	49,000 ft^2	40,000 ft^2	835,000 ft^2
Portfolio Floor Area	65 million ft^2	250 million ft^2		950 million ft^2		11 million ft^2		1.3 billion ft^2
Expected Energy Savings (Versus Current Prototype for new construction or Pre-Retrofit for existing)	TBD	28%	5%	33%	—	30%	16%	—
Expected Energy Savings (Versus Code Baseline)	TBD	35%	50%	41%	51%	40%	41%	—
Expected Electricity Savings (Versus Code Baseline)	TBD	2.0 million kWh/yr	1.3 million kWh/yr	2.8 million kWh/yr	3.4 million kWh/yr	0.8 million kWh/yr	1.4 million kWh/yr	11.7 million kWh/yr electricity
Expected Natural Gas Savings (Versus Code Baseline)	TBD	3,300 therms/yr	32,200 therms/yr	61,000 therms/yr	(18,000) therms/yr	22,300 therms/yr	15,500 therms/yr	116,000 therms/yr natural gas
Expected Energy Cost Reductions (Versus Code Baseline)	TBD	Not available	Not available	$253,000/yr	$245,000/yr	$77,000/yr	$97,000/yr	$672,000/yr
Simple Payback Period	TBD	<5 Years	<5 Years	4.8 Years	3.9 Years	<5 Years	<5 Years	—

*DOE Better Buildings Challenge Participant: see http://www4.eere.energy.gov/challenge/

Projects at a Glance

Four retail food sellers participated in CBP (see "Projects at a Glance" table): SUPERVALU, Target, Walmart, and Whole Foods Market. New construction and existing building retrofit projects were undertaken. The companies represented a range of sizes: Whole Foods Market had 300 stores and approximately 11 million ft^2; Walmart had 4300 stores and 950 million ft^2 (in the United States). The total floor area of the projects included in the seven case studies was 835,000 ft^2; individual stores ranged from 40,000 ft^2 to 200,000 ft^2. At the time of publication, the SUPERVALU retrofit was still in the design phase and energy savings were being estimated.

The total floor area of the company portfolios was 1.3 billion ft^2 at the time of publication. As part of CBP, DOE helped companies analyze the nationwide savings potential of the EEMs implemented in CBP pilot projects. EEMs that performed as expected in the CBP pilot projects were incorporated into companies' new construction specifications and standard retrofit packages. While the companies did not commit to a certain level of CBP pilot project replication in terms of square footage, they all maintain a regular cycle of store renovation, providing continual opportunities for saving energy based on CBP successes. Lessons learned during CBP were also available for DOE Better Building Challenge participants such as SUPERVALU that had committed to 20% company-wide energy savings by 2020.

Some stores occupy buildings owned by the company; others are in leased space. In general, occupying leased space does not represent a barrier to energy efficiency. Because the companies pay the entire utility bill (net lease), they negotiate lease terms that allow them to specify the store design and equipment.

SUPERVALU's stores are traditional grocery stores and supermarkets; others, such as Target's and Walmart's, combine general merchandise and retail food sales in much larger footprints. Whole Foods Market's stores are typical grocery stores in some ways but also include substantial food preparation and cooking, giving them an energy profile somewhere between a food sales and a food service establishment.

Each company had its own process for improving energy efficiency and propagating design changes throughout its building portfolio. Companies such as Target maintained internal engineering departments that continually search for additional incremental savings; others depended on outside consultants. Some companies maintained a single "prototypical" store design that was replicated and adapted for regional conditions. Others, such as Whole Foods Market, made decisions at the regional level and had to develop systems to spread best practices and innovations across the company. Some companies tracked energy use and controlled store operation from a central location; others used decentralized tracking and control systems.

Successful Strategies

Companies that value energy efficiency and use it to their advantage have developed strategies to ensure their energy reduction efforts are successful. Each strategy helps a company to take advantage of market drivers or overcome barriers that have stood in the way of energy saving and sustainability goals. Many strategies are shared with the general merchandise sector, though the particular challenges faced by grocery stores merit some additional strategies. Strategies that broadly applied across the featured projects included:

- **Consider noneconomic benefits.** Energy efficiency improvements may yield additional benefits beyond the bottom line, such as improved thermal or visual comfort. These improvements attract customers, keep them shopping longer, and improve employee productivity. For example, putting doors on refrigerated display cases can have an impact by improving product integrity and customer comfort.

- **Verify and maintain energy savings.** To maximize energy savings, companies verify that their projects perform as designed after the grand opening and take action if they do not. Because refrigeration equipment is energy intensive and has strict requirements for dependable operation, grocery stores tend to be well instrumented to collect energy and environmental data. Successful companies use these data to measure the performance of building systems over time and keep their buildings "tuned up" to make sure their investment in efficiency pays off as expected.

- **Collect customer feedback.** Often, resistance to EEMs such as doors on refrigerated display cases or daylighting is based on untested assumptions about what customers do or do not like. Companies can be pleasantly surprised by positive customer reactions when they test these strategies in pilot stores.

- **Make saving energy part of the company brand.** Corporate management at many companies recognizes that publicizing sustainability practices can garner customer interest and build loyalty. Successful companies use energy efficiency and other environmentally responsible practices to illustrate their corporate values and differentiate themselves in the marketplace.

- **Focus on corporate commitment.** Companies establish clear lines of authority and responsibility for managing and implementing energy efficiency initiatives. They reward individuals or teams for actions they take to improve energy efficiency.

- **Set quantitative whole-building energy goals.** Having a target enables and motivates effective action. Several companies have used energy modeling in the design process to identify how far energy consumption can be reduced cost effectively (according to each company's economic criteria) in different parts of the country. Companies use this information to craft overall action plans for saving energy.

- **Get operations, branding, and marketing buy-in.** Companies need to protect their brands and ensure positive customer experiences. To succeed, they make saving energy part of these functions and give their stakeholders a voice in design and acquisition decisions around energy efficiency. Without aligned goals, different parts of a company may work at cross-purposes with unwanted results.
- **Invest in resources and analysis.** Companies train their internal staff and contract with outside specialists to help make informed decisions based on analysis of the best energy-saving technologies and incentives available for their particular situation.
- **Establish consistent financial metrics.** All companies are concerned about their profit margins. To successfully cut energy use, they establish financial metrics that they apply consistently to their investments. These companies recognize that energy efficiency offers an opportunity for a solid return and are willing to let the numbers speak for themselves.
- **Look for first-cost savings.** Especially in new construction, energy efficiency in buildings can lead to downsizing of heating, ventilating, and air-conditioning (HVAC) systems. The resulting first cost savings can improve the business case for EEMs when considered as a whole-building package where they might appear uneconomic if evaluated in isolation.
- **Recognize value streams.** For most investments companies look beyond first costs. They recognize and value investments that provide steady income or avoided costs over time. Such investments, which include energy efficiency, help to mitigate the risks of unforeseen cost escalation. To achieve energy savings, they use full life cycle costing when making efficiency investment decisions. A sole focus on quick paybacks can lead to wasted opportunities for long-term cost savings.
- **Seek continuous improvement.** Improving energy efficiency is not a one-time task. To reduce energy use over time, companies stay up-to-date on the latest technological developments and best practices and make energy use assessment and continuous improvement parts of regular operational practices. They also pilot technologies to assess performance and reliability before rolling them out.
- **Negotiate leases that facilitate saving energy.** In leased spaces, companies negotiate terms to avoid the so-called "split-incentive" barrier to saving energy. They can control design and equipment decisions in new construction and reserve the right to replace aging mechanical systems in existing buildings to avoid mounting maintenance and energy costs toward the end of the equipment's life cycle.
- **Take advantage of utility rebates and tax incentives.** Companies improve the business case for efficiency investments by taking advantage of utility rebates[6] to offset up-front capital costs. Sometimes it even pays for them to hire a third party to handle rebate logistics. Other opportunities include the 179D federal tax deduction,[7] which applies to the cost of energy efficiency investments in commercial buildings.

[6] See the Database of State Incentives for Renewables and Energy Efficiency (DSIRE) at http://www.dsireusa.org/
[7] DOE 179D Calculator: http://apps1.eere.energy.gov/buildings/commercial/179d/

Highlighted Technical Solutions

- ***Demand-responsive equipment and controls.*** There are multiple opportunities to ramp down lighting, HVAC, refrigeration, and kitchen equipment in response to decreased demand.
- ***Doors on cases.*** Companies are finding that doors on medium-temperature refrigerated display cases are acceptable to customers and can dramatically cut refrigeration energy consumption, operating costs, and required refrigeration capacity.
- ***Solid-state lighting.*** Light-emitting diodes (LEDs) in refrigerated cases last longer and introduce less heat into the cases than fluorescent lights. Solid-state track lighting provides a more efficient and longer lived option for spotlighting produce. LEDs are now also being used for ambient store lighting because of their low energy consumption, long lifetime, and ability to dim in response to daylight.
- ***Efficient fan motors.*** Refrigerated case evaporator fans run constantly. When added up over multiple motors, shifting from shaded pole and permanent split capacitor fan motors to electronically commutated motors saves energy and money over time.
- ***Efficient humidity control.*** Efficient dehumidification, for example by using a desiccant wheel in the air handling unit serving the sales floor, can reduce refrigeration loads, required refrigerated case door anti-sweat heat, and evaporator coil defrosting.
- ***Waste heat reclamation.*** Waste heat from the refrigeration system can significantly replace energy that would otherwise need to be purchased for space and water heating.

Energy Efficiency Measures

Based on the experiences of leading companies, as reflected in DOE Advanced Energy Design Guides for new construction and Advanced Energy Retrofit Guides[8] for existing buildings as well as the CBP case studies presented here, many cost-effective (as defined by the criteria of the industry partners) EEMs are available that can achieve aggressive energy savings (see "Recommended EEMs" table below) in grocery stores and supermarkets. They are low risk, using readily available technologies. Some are low- or no-cost measures that can be included in regular maintenance procedures. When combined with best practices for integrated design, procurement, controls, and delivery assurance, the list below provides an approach to cutting energy use across all building systems, adding up to significant whole-building savings. EEMs that are not applicable in all climate regions are marked with an asterisk (*) in the table below. You should check that climate-dependent solutions are a good fit in your region.

Recommended EEMs

Envelope
Weatherstrip and caulk windows and doors where drafts can be felt.
*Increase roof insulation as part of other work required for maintenance.
*Add reflective roof covering.
*Design vestibules to prevent a direct path for wind to carry outdoor air into the store.
Lighting
Replace T12 fluorescent lamps and magnetic ballasts with high-efficiency T8 lamps and instant-start electronic ballasts or light-emitting diodes.
Calibrate controls and optimize settings based on building use patterns and daylight availability.
Adjust light levels to within 10% of the Illuminating Engineering Society (IES) recommendations for the tasks conducted in each area by delamping or relamping.
Replace track lighting with ceramic metal halide or LEDs.
*Increase the availability of daylight by adding skylights; install photosensors; use dimming ballasts to dim lights when daylighting is sufficient.
Improve janitorial workflow to consolidate activities, to reduce operating hours for lighting.
Manage lighting schedules on the sales floor by turning off all lights during unoccupied hours to the extent possible.
Use sensors to control lighting in back-of-house areas (automatic on/automatic off in restrooms and stockrooms; manual on/automatic off otherwise).
HVAC
Test, adjust, and balance air handling units and flow modulation devices to ensure conditioned air volumes meet load requirements.
Verify or establish a comprehensive maintenance protocol for HVAC equipment.
*Verify correct operation of outside air economizer.
Ensure correct refrigerant charge in cooling systems and heat pumps and repair any refrigerant leaks.
Increase thermostat setback or setup when building is unoccupied.
Reoptimize supply air temperature reset baset on current building loads and use patterns.
Verify adequate deadband between heating and cooling.
Move improperly located thermostats to prevent over- or undercooling and heating.
Optimize equipment staging and sequence of operation.
Suspend ventilation during unoccupied periods.
Install variable-speed drive kitchen hood exhaust fans with demand control and design makeup air units to use outdoor air.
*Replace standard furnace with a high-efficiency condensing furnace.
Replace inefficient motors with rightsized National Electrical Manufacturer Association (NEMA) premium efficiency rated motors.
Convert constant volume or dual duct air handling systems to variable air volume.
Upgrade to demand controlled ventilation to reduce outdoor airflow during partial occupancy.

[8] Advanced Energy Design Guides and Advanced Energy Retrofit Guides are available at the DOE Commercial Buildings Resource Database: http://apps1.eere.energy.gov/buildings/commercial/resource_database

Recommended EEMs

*Recover energy from exhaust airstreams using heat-exchange or enthalpy-exchange technologies.
*Install evaporative condenser for air-conditioning system.
*Reduce sales floor dew point to reduce refrigeration system load, required anti-sweat heat, and defrost energy.
Downsize mechanical systems to better match required capacity and improve part-load efficiency.
Clean or replace air, water, and lubricant filters.
Refrigeration
Ensure that open refrigerated cases are covered when the store is closed.
Put doors on medium temperature refrigerated display cases.
Raise set points in refrigerated cases when possible.
Clean and calibrate humidity sensors that control anti-sweat heaters.
Repair or replace gaskets and seals on refrigerated cases.
Verify correct charge in refrigeration systems and repair any refrigerant leaks.
Verify optimal head and suction pressures.
*Lower minimum saturated condensing temperature and use electronic expansion valves.
*Use anti-sweat heater controls that respond to sales floor dew point.
Ensure that airflows in refrigerated cases are not blocked by improperly stocked shelves.
Install high-efficiency evaporator fans with electronically commutated motors (ECMs) .
*Install evaporative condensers for refrigeration systems.
Install strip curtains and weather seal walk-in freezer doors.
Replace refrigerated display case lighting with LEDs.
Capture waste heat for air and service water heating.
Plug and Process Loads
Replace desktop computers with laptop computers where feasible; control computer power-management settings facility-wide through software or logon scripts, ensuring settings cannot be overridden.
Use timers for compressors and turn off lights on vending machines.
Provide power strips in easy-to-access locations to facilitate equipment shutdown.
Apply standby mode to registers when not in use; turn registers off when store is closed.
Schedule cooking activities to use equipment at full capacity.
Verify that airflow paths around transformers are not blocked.
Verify balanced three-phase power and proper voltage levels.
Replace kitchen, deli, and bakery appliances with ENERGY STAR® models and turn off equipment at night.
Service Hot Water
Reduce set point for service hot water to 120°F, with boost heating for dishwashers.
Install low-flow aerators on faucets.
Disable circulation pumps when building is unoccupied.

When taken together, checkout area equipment can consume significant energy. Make sure to install efficient point of sale equipment with the ability to go into standby or off modes.

NREL/PIX 19503

Putting doors on refrigerated display cases, lighting them with LEDs, and installing efficient evaporator coil fans are proven technical solutions implemented by multiple companies leading the industry in saving energy.

NREL/PIX 18606

Food preparation and cooking areas are important, yet under appreciated, contributors to overall store energy use. Efficient equipment and well-designed cooking exhaust systems are effective strategies to save energy in these areas.

NREL/PIX 18614

Additional Resources

179D Federal Tax Deduction Calculator
http://apps1.eere.energy.gov/buildings/commercial/179d

American Council for an Energy Efficient Economy
http://www.aceee.org

American Society of Heating Refrigerating and Air-Conditioning Engineers (ASHRAE)
http://www.ashrae.org/

Consortium for Energy Efficiency
http://www.cee1.org/com/com-main.php3

Database of State Incentives for Renewables and Energy Efficiency (DSIRE)
http://www.dsireusa.org

DOE Commercial Buildings Resource Database
http://apps1.eere.energy.gov/buildings/commercial/resource_database

ENERGY STAR information for grocery stores
http://www.energystar.gov/ia/business/EPA_BUM_CH11_Supermarkets.pdf

EPA Greenchill Partnership
http://www.epa.gov/greenchill/

Food Marketing Institute
http://www.fmi.org/industry-topics/sustainability/key-sustainability-tools-and-resources/energy

Northwest Energy Efficiency Alliance BetterBricks
http://www.betterbricks.com/grocery-stores

PECI Grocery and Refrigeration
http://www.peci.org/ESG

Southern California Edison Refrigeration & Thermal Test Center
http://www.sce.com/b-sb/design-services/ttc/rttc/refrigeration-thermal-test-center.htm

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